

**Surface Climate Processes and Environmental Interactions**  
**EARTH SC / ENVIR SC 2C03**  
**Term-1, 2016-17**

**INSTRUCTOR:**

Dr. Altaf Arain  
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**OFFICE:**

GSB, Room 214

**OFFICE HOURS:**

Walk-in or by appointment

**TEACHING ASSISTANTS:**

Eric Beamesderfer  
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**COURSE OBJECTIVES:**

In this course, we focus on understanding the near-surface climate processes by which energy (radiation and heat) and mass (water and gas such as CO<sub>2</sub>) is stored and transferred between the Earth and the Atmosphere in natural and human-modified landscapes. We primarily focus on the planetary boundary layer, which ranges from a few meters below the surface to a few hundred meters above the surface.

Upon completing this course, you should be able to:

- a) Define the various layers of the Earth-Atmosphere boundary, and describe the energy and mass exchange processes occurring within each;
- b) Demonstrate an ability to analyze and resolve energy and mass budgets over a variety of vegetated and non-vegetated surfaces;
- c) Explain and use the relations that are helpful in modeling/estimating exchanges of mass and energy within and between the components of the Earth-atmosphere system;
- d) Effectively use analysis software (e.g. MS Excel) with the scientific methods to investigate surface climate processes and extract understanding from observations; and,
- e) Use your knowledge of near-surface climate dynamics to synthesize new and holistic understanding of complex Earth-atmosphere systems and climate scenarios.

**LECTURES:**

Monday, 8:30 am - 9:20 am, Togo Salmon Hall, Room B105  
Wednesday, 8:30 am - 9:20 am, Togo Salmon Hall, Room B105

**LAB SECTIONS:**

<u>No.</u>	<u>Day</u>	<u>Time</u>	<u>Room</u>	<u>Teaching Assistant</u>
L01	Friday	9:30am – 11:20am	BSB 122	Eric Beamesdefer
L02	Tuesday	8:30am – 10:20am	KTH B107	Olivier Champagne
L04	Monday	2:30pm – 4:20pm	BSB 238	Eric Beamesdefer
L05	Friday	12:30pm – 2:20pm	KTH B107	Olivier Champagne

**TEXTBOOK:**

Oke, T.R., 1987, Boundary Layer Climates, 2<sup>nd</sup> Ed. Routledge. ISBN: 0-415-04319-0  
(available in the Campus Store or other venues)

## **PREREQUISITES:**

An interest in Environmental processes or one of the following courses:

Prerequisite: One of EARTHSC 1G03, ENVIRSC 1A03, 1B03, 1C03, 1G03, ISCI 1A24 A/B

Cross list: ENVIR SC 2C03, EARTH SC 2C03

## **ASSESSMENT:**

Lab assignments	30% (3 @ 10% each)
In-class quizzes	10% (3 @ 3.3% each)
Midterm exam	20%
Final exam (cumulative)	40%

## **LECTURE SCHEDULE**

See lecture schedule at the last page of this document

## **LAB SCHEDULE:**

Labs will be assigned and due in your assigned lab section unless otherwise stated.

	<u>Assigned</u>	<u>Due</u>
<b>Lab 1</b>	Week of 12-Sep	Friday Sept-30
<b>Lab 2</b>	Week of 03-Oct	Friday Oct-21
<b>Lab 3</b>	Week of 07-Nov	Friday Nov-25

## **MIDTERM EXAM**

Mid-term Exam – Wednesday, November 2nd (in classroom)

## **IN-CLASS QUIZZES**

In-class quizzes will be administered at three points during the term. The quizzes will use either a multiple-choice or short-answer format and the questions will contain material covered in the readings and in-class sessions. The dates of the quizzes will not be posted beforehand.

## **AVENUE TO LEARN:**

This course will be managed through Avenue to Learn ([avenue.mcmaster.ca](http://avenue.mcmaster.ca)). It is your responsibility to check the course site regularly (daily) to obtain all necessary materials and remain up-to-date on course developments.

## **SUBMISSION OF ASSIGNMENTS**

At the time at which the assignment is distributed, you will be informed of the due date, time and location. You may be asked to submit your assignments in one of the following manners:

- At the start of your lab, on the assignment's due date.
- Submission of digital copy via Avenue to Learn
- Submission of assignment hard copy to a dropbox location on the 2<sup>nd</sup> floor of General Sciences Building (GSB). In these cases, your assignment must be submitted before 4:30pm on the due date. You can submit assignments to the after-hours drop box located at the western end of GSB near elevator. However; these assignments are collected and date stamped on the following day -- not the date you physically put the assignment in the after-hours drop box.

Write your name, student ID number, course name (e.g. Earth Sc 2C03), TA name, assignment number, and due date on the first page of your assignment.

### **MISSING OR LATE WORK**

All work is due on the date stated, at the beginning of class, unless other arrangements have been made in advance with the instructor. A late penalty of 10% per day will apply after the due date (weekends included).

### **McMASTER STUDENT ABSENCE FORM (MSAF)**

In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar "Requests for Relief for Missed Academic Term Work". Please check most recent regulations for this term.

MSAF forms are available in MOSAIC Student Center (in the drop down menu under Academics)

### **ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES:**

Students with disabilities may receive accommodations to assist them in the completion of their assignments and exams. Please contact the Centre for Student Development (MUSC lower level) and the instructor as soon as possible if you require assistance.

### **ACADEMIC DISHONESTY:**

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity.

Academic dishonesty consists of misrepresentation by deception or by other fraudulent means and can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university. It is your responsibility to understand what constitutes academic dishonesty. For information on the various kinds of academic dishonesty please refer to the Academic Integrity Policy available at:

<https://www.mcmaster.ca/academicintegrity/>

*The following illustrates only three forms of academic dishonesty:*

- *Plagiarism (e.g. submission of work that is not one's own or for which other credit has been obtained)*
- *Improper collaboration in group-work*
- *Copying or using unauthorized aids in tests and examinations*

### **COURSE MODIFICATION:**

The instructor and university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes.

## **COURSE CONTENT - EARTH SC / ENVIR SC 2C03**

This course will consist of an introduction to near-surface climate processes, as well as study of climate dynamics in natural and human-modified systems. Ultimately, this understanding will be used to explore complex climate feedback mechanisms and climate issues.

Topics covered include:

1. Surface Radiation, Energy and Water Budgets
2. Surface Climate Processes
  - a. Active Surface and Subsurface
  - b. Momentum and the Wind Profile
  - c. Sensible and Latent Heat Flux
  - d. Spatial Variability and Fetch Relations
  - e. Energy and Mass Balance of Ecosystems
3. Natural Surface Climates
  - a. Snow and Ice
  - b. Lakes and Oceans
  - c. Arctic Ecosystems
  - d. Forest Ecosystems
  - e. Crops
4. Complex Climates of Non-Uniform Terrain
  - a. Spatial Inhomogeneity Effects
  - b. Topography Effects
5. Surface Processes, Feedback, and Climate Change

## EARTH SC / ENVIR SC 2C03, COURSE SCHEDULE

	<b>Date</b>	<b>Topic</b>	<b>Text Pages</b>
1	Wed-Sep 7	Course introduction; Scales and systems view	3-7
2	Mon-Sep 12	Energy & Mass Balances I: Radiation	8-20
3	Wed-Sep 14	Energy & Mass Balances II: Net Energy & Mass	20-32
4	Mon-Sep 19	Energy & Water Exchanges in Boundary Layer I	33-42
5	Wed-Sep 21	Energy & Water Exchanges in Boundary Layer II	
6	Mon-Sep 26	Sub-Surface Soil Water & Energy Exchanges I	43-51
7	Wed-Sep 28	Sub-Surface Soil Water & Energy Exchanges I	
8	Mon-Oct 3	Atmospheric Stability & Wind Profiles I	51-59
9	Wed-Oct 5	Atmospheric Stability & Wind Profiles II	
	<b>Oct 10-14</b>	<b>Mid-term Recess – No Classes</b>	
10	Mon-Oct 17	Energy & Mass Fluxes I	59-71
11	Wed-Oct 19	Energy & Mass Fluxes II	
12	Mon-Oct 24	Outer layer climates	71-76
13	Wed-Oct 26	Non-Vegetated Surfaces – Desert & Peat	79-84
14	Mon-Oct 31	Non-Vegetated Surfaces – Ice & Snow	84-98
	<b>Wed-Nov 2</b>	<b>MID-TERM EXAMINATION (In-Class)</b>	
15	Mon-Nov 7	Non-Vegetated Surfaces - Water	98-110
16	Wed-Nov 9	Vegetated Surfaces – Introduction	110-117
17	Mon-Nov 14	Vegetated Surfaces – Leaves	117-124
18	Wed-Nov 16	Vegetated Surfaces - Plant Cover & Crops	124-141
19	Mon-Nov 21	Vegetated Surfaces - Forests	141-157
20	Wed-Nov 23	Vegetated Surfaces–Boreal & Temperate Forests	
21	Mon-Nov 28	Non-uniform terrain: Spatial inhomogeneity	158-170
22	Wed-Nov 30	Non-uniform terrain: Effects of Topography	171-189
23	Mon-Dec 5	Climate Change Feedbacks	
24	Wed-Dec 7	Course Summary & Course Evaluations	
	<b>Dec 9-22</b>	<b>FINAL EXAMINATIONS</b>	